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**Organic and organo-mineral fertilizers — Determination of the total organic carbon  
(TOC) content by dry combustion**

**Einführendes Element — Haupt-Element — Ergänzendes Element**

**Élément introductif — Élément central — Élément complémentaire**

**ICS:**

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## European foreword

This document (CEN/prEN 17776) has been prepared by Technical Committee CEN/TC 260 “Fertilizers and liming materials”, the secretariat of which is held by DIN.

This is a working document.

This document will supersede CEN/TS 17776:2022. In comparison with the previous edition the following main changes have been made:

Introduction revised according to the recommended wording from FprEN 17704.

Analysis of blends added into the Scope

Terms and definitions revised

Added method for indirect determination of organic carbon

Added principle of indirect method

Renumbering and reorganizing of relevant paragraphs

Revision of reagents with respect to changes in the text

Added formula for indirect method

Annex A – deleted note

Bibliography revised

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive(s) / Regulation(s).

## Introduction

The European Committee for Standardization (CEN) was requested by the European Commission (EC) to draft European standards or European standardization deliverables to support the implementation of Regulation (EU) 2019/1009 of 5 June 2019 laying down rules on the making available on the market of EU fertilizing products (“FPR” or “Fertilising Products Regulation”) [1].

Organic and organo-mineral fertilizers are highly valuable tools in modern agriculture. Standardization was identified as having an important role in order to promote the use of organic and organo-mineral fertilizers. The work of CEN/TC 260 seeks to improve the reliability of the supply chain, thereby boosting the confidence of farmers, industry, and consumers in fertilizer products. This initiative will promote and support commercialisation of the European organic and organo-mineral fertilizers industry.

The preparation of this document is based on a standardization request to CEN by the European Commission and the European Free Trade Association (Mandate M/564 and relevant amendments) concerning the modernization of methods of analysis of fertilizers within the framework of Regulation (EU) 2019/1009 of the European Parliament and of the Council. This standardization request, presented as M/564, also contributes to the Communication on “Innovating for Sustainable Growth: A Bio economy for Europe”.

The method described in this document is based on the standard for determining organic carbon in sludges, biowaste, soil, and other solid matrices (EN 15936).

**WARNING** — Persons using this document should be familiar with usual laboratory practice. This document does not purport to address all of the safety issues, if any, associated with its use. It is the responsibility of the user to establish appropriate health and safety practices and to ensure compliance with any national regulatory conditions.

**IMPORTANT** — It is absolutely essential that tests conducted according to this document are carried out by suitably trained staff.

## 1 Scope

This document is applicable to the fertilizing products blends where a blend is a mix of at least two of the following components [Fertilizers/Liming Materials/Soil Improvers/Growing Media/Inhibitors/Plant Biostimulants] and where the following category [organic fertilizers, organo-mineral fertilizers] is the highest % in the blend by mass or volume, or in the case of liquid form by dry mass. If [organic fertilizers, organo-mineral fertilizers] is not the highest % in the blend, the European Standard for the highest % of the blend applies. In case a fertilizing product blend is composed of components in equal quantity, the user decides which standard to apply”.

This document specifies a method for the determination of total organic carbon (TOC) by elemental analysis using dry combustion. The method is applicable to organic and organo-mineral fertilizers containing more than 1 g carbon per kg of dry matter (0,1 %), with the exclusion of organo-mineral fertilizers containing urea-formaldehyde polymers as long as there is no method available to assess carbon in urea-formaldehyde polymers.

Sampling and sample preparation are not part of this document.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CEN/TS 17771, *Organic and organo-mineral fertilizers — Determination of the nitrogen content*

CEN/TS 17773, *Organic and organo-mineral fertilizers — Determination of the dry matter content*

EN 15705, *Fertilizers — Determination of urea condensates using high-performance liquid chromatography (HPLC) — Isobutylidenediurea and crotonylidenediurea (method A) and methylen-urea oligomers (method B)*

EN ISO 3696:1995, *Water for analytical laboratory use — Specification and test methods (ISO 3696: 1987)*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

### 3.1 total organic carbon

#### TOC

quantity of carbon that is converted into carbon dioxide by combustion and which is not liberated as carbon dioxide by acid treatment

### 3.2 total inorganic carbon

#### TIC

quantity of carbon that is liberated as carbon dioxide by acid treatment

### 3.3 total carbon

#### TC

quantity of carbon present in the sample in the form of organic, inorganic and elemental carbon

Note 1 to entry: In agreement with Regulation (EU) 2019/1009 [5], carbon derived from urea and polymers containing urea are not considered as organic in this document.

## 4 Principle

### 4.1 Method A (direct method):

The carbon dioxide released by the following combustion in an oxygen containing gas flow free of carbon dioxide, is measured by infrared spectrometry, thermal conductivity detection, or by the detector provided by the equipment used. To ensure complete combustion, catalysts and/or modifiers can be used. The released amount of carbon dioxide indicates the TOC.

The carbonates present in the sample shall be previously removed by treating the sample with acid. The carbon dioxide released by the following combustion step indicates the TOC directly.

### 4.2 Method B (indirect method):

TOC is obtained by the difference between the results of the measurements of TC and TIC. The total carbon (TC) present in the sample is converted into carbon dioxide by combustion in an oxygen containing gas flow free of carbon dioxide. To ensure complete combustion, catalysts and/or modifiers can be used. The released amount of carbon dioxide is measured e.g. by infrared spectrometry, thermal conductivity detection, or other suitable techniques.

The TIC is determined separately from another sub-sample by means of acidification and purging of the released carbon dioxide. The carbon dioxide shall be measured by one of the techniques mentioned above.

## 5 Applicability

The methods 4.1 and 4.2 are applicable to organic and organo-mineral fertilizers both solid and liquid.

The method 4.1 is not selective, because combustion occurs for both organic and inorganic carbon.

## 6 Interferences

In the case of experience with samples containing high amounts of carbonates (e.g. carbonates to TOC ratio higher than 10) the operator shall take care to correctly eliminate all the carbonates to make sure to produce reliable TOC results.

When present, carbon from urea and urea-condensates carbides is determined as organic carbon using the method described in this document. An interpretation of the measured value may therefore be problematic in cases where the sample contains relevant levels of the above-mentioned components. If needed, these components shall be determined separately by means of a suitable validated method and be recorded in the test report.

Carbon from urea and urea-condensates (crotonyliden diurea, CDU and isobutyliden diurea, IBDU), determined separately using CEN/TS 17771 and EN 15705 must be subtracted. If this is done this shall be reported by the laboratory.

## 7 Sampling

Sampling and sample preparation should be performed, following the principles described in EN 1482 (all parts) with appropriate adaptations, required to account for specificities of organic and organo-mineral fertilizers. Grinding of the laboratory sample is recommended for homogeneity reasons. The sample shall then pass through a sieve of 0,5 mm.

## 8 Reagents

Water, with a specific conductivity not higher than 0,2 mS/m at 25 °C, free from the elements to be determined. All reagents shall be of recognized analytical grade.

**8.1 Potassium hydrogen phthalate,  $C_8H_5O_4K$ .**

**8.2 Acetanilide,  $C_8H_9NO$ .**

**8.3 Atropine,  $C_{17}H_{23}NO_3$ .**

**8.4 Ethylenediaminetetraacetic acid, (EDTA),  $C_{10}H_{16}N_2O_8$ .**

**8.5 Diethylenetriaminepentaacetic acid, (DTPA),  $C_{14}H_{23}N_3O_{10}$ .**

**8.6 Sodium salicylate,  $C_7H_5O_3Na$ .**

**8.7 Tetrasodium ethylenediamine tetraacetate-tetra-hydrate,  $Na_4$ -EDTA · 4H<sub>2</sub>O ( $C_{10}H_{12}N_2O_8Na_4 \cdot 4H_2O$ ), heated at 80 °C for 2 h.**

Other forms of  $Na_4$ -EDTA hydrates may be used if the water content is exactly known. In these cases, the composition of the control mixtures shall be recalculated accordingly (see also 5.8).

**8.8 Aluminum oxide,  $Al_2O_3$ , neutral, granular size < 200 μm, annealed at 600 °C.**

**8.9 Calcium carbonate,  $CaCO_3$ .**

**8.10 Sodium carbonate,  $Na_2CO_3$ , anhydrous.**

**8.11 Control mixture**

Control mixture prepared from sodium salicylate (8.6), calcium carbonate (8.9),  $Na_4$ -EDTA · 4H<sub>2</sub>O (8.7) and aluminum oxide (5.6) in a mass ratio of 1,00 : 4,36 : 1,97 : 8,40.

The mixture shall be homogenised. It should contain 33,3 g/kg total inorganic carbon and 66,6 g/kg TOC (e.g. 6,36 g of sodium salicylate, 27,78 g of calcium carbonate, 12,50 g of  $Na_4$ -EDTA · 4H<sub>2</sub>O, 53,36 g of aluminum oxide).

**8.12 Chromosorb®<sup>1</sup> (inert absorbent material for determination on fluid samples).**

**8.13 Non-oxidizing mineral acid used for carbon dioxide expulsion, e.g. phosphoric acid H<sub>3</sub>PO<sub>4</sub> (w = 85 %).**

NOTE 2 Due to possible corrosion by hydrochloric acid, phosphoric acid is preferred.

**8.14 Carrier gas, e.g. synthetic air, nitrogen, helium, oxygen or argon, free of carbon dioxide and organic impurities in accordance with the manufacturer's instructions.**

## **9 Apparatus**

**9.1 Analytical balance, capable of weighing to the nearest 1 mg or better.**

**9.2 Equipment for determination of carbon in solids, with accessories.**

**9.3 Crucibles, capsules or boats, made of e.g. silver, tin, ceramics or platinum.**

Tin and nickel crucibles are not acid-resistant. In case of the necessity to remove inorganic carbon (see 10.2.3), silver or ceramics vessels shall be used.

**9.4 Pasteur pipettes.**

**9.5 Drying system, thermostatically controlled and capable of maintaining temperature of (105 ± 2) °C.**

**9.6 Desiccator, with an active drying agent such as silica gel.**

**9.7 Evaporating dish or crucible, temperature tolerant laboratory vessel with a temperature resistance of at least 110 °C. Suitable materials are metallic, ceramic, borosilicate glass or quartz, porcelain, etc.**

**9.8 Purging unit for TIC determination, for Method B only.**

## **10 Procedure**

### **10.1 General**

The mass of the test portion should be as large as possible and shall be chosen so that the liberated quantity of carbon dioxide lies within the working range of the equipment and calibration. See example in Table A.1.

### **10.2 Method A - determination of the TOC – direct method**

#### **10.2.1 Preparation of solid samples**

For solid fertilizers dried samples shall be used.

The operator shall weigh an aliquot of sample prepared according to 7 into a suitable vessel (9.3) using the precision balance (9.1).

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<sup>1</sup> Chromosorb® is the trade name of a product. This information is given for the convenience of users of this document and does not constitute an endorsement by CEN of the product named. Equivalent products may be used if they can be shown to lead to the same results.



Moist or paste-like samples may be mixed with aluminum oxide (8.6) until granular material is obtained and then be comminuted and homogenised. In this case, the ratio of the used masses of aluminum oxide to sample shall be considered in the calculation of TOC (according to Clause 11).

The following tasks shall be performed:

- Close the vessel (9.3) according to the manufacturer's specifications, taking care not to break it and not to touch it with hands.
- Take the mass when the vessel is closed.

### 10.2.2 Preparation of liquid samples

#### Option A

For liquid fertilizers the operator shall put a little Chromosorb® (8.9) in the vessel (9.3) in order to have a layer of inert material on the bottom of the vessel (9.3).

The operator shall tare the vessel with Chromosorb®, and then, using the Pasteur pipette (9.4) shall put a small aliquot of liquid sample into the vessel (9.3).

The following tasks shall be performed:

- Close the vessel (9.3) according to the manufacturer's specifications, taking care not to break it and not to touch it with hands.
- Take the mass when the vessel (6.3) is closed.

#### Option B

Alternatively, without using Chromosorb®(8.9), the operator shall dry an amount of liquid sample in an evaporating dish or crucible (9.7) into the drying system (9.5) set at  $(105 \pm 2)$  °C until the residue appears dry, typically overnight.

After cooling the sample in the desiccator (9.6) the operator shall homogenise the dried sample and shall proceed as described for solid samples in 10.2.1.

### 10.2.3 Removal of inorganic carbon and determination of the TOC

In order to remove the inorganic carbon prior to the determination of TOC, the sample is carefully treated with a small volume of non-oxidizing mineral acid (8.10). After weighing the sample in the crucible (9.3), add the acid slowly (dropwise) to avoid foaming and splashing of the sample. Add as little acid as possible but enough to soak the entire sample and to remove the inorganic carbon completely.

An automatic dispenser system allowing small increments of non-oxidizing acid diluted with water (1 : 10; v/v) to be added at a time may be used.

Generally, 4 h of waiting is enough time for the complete removal of carbon dioxide. If moistening with the acid is difficult, the sample may be dampened beforehand with as little water as possible.

The moisture can be partly removed before combustion. The temperature during this sample treatment shall not exceed 40 °C.

Burn the sample in the carrier gas containing oxygen (8.11).

The combustion temperature shall be high enough to convert the organic carbon completely to carbon dioxide. The use of catalysts e.g. copper may increase the recovery.

The temperature range of commercially available instruments is between 900 °C and 1 500 °C.

During the combustion of reactive samples explosion or fuming can be prevented by covering the sample with inert material e.g. silica sand after removal of the inorganic carbon.

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The total carbon dioxide released during the combustion is measured using one of the detection methods infrared spectrometry, thermal conductivity detection, or other suitable techniques, and is expressed as carbon.

NOTE 3 The quality of results is dependent on experience and practice, especially regarding the steps before the determination of TOC. Use of automatic dispensing units regarding removal of carbonates prior to determination of TOC can improve the performance of the method.

NOTE 4 Corrosion of the combustion device can occur as a result of the acid remaining in the sample. Salt deposits can contaminate the system.

### 10.2.4 Calibration

If a relative method is used for detection, e.g. infrared detection, calibration is necessary.

Examples of calibration substances suitable for TOC are potassium hydrogen phthalate (8.1), acetanilide (8.2), atropine (8.3), EDTA (8.4).

Na<sub>4</sub>-EDTA (8.5) shall not be used for calibration as it is used as control substance.

Other calibration substances may be used provided their suitability is checked.

The following procedure should be applied for calibration:

- establish the preliminary working range;
- measure a minimum of five standard samples. The concentration of these standard samples shall be distributed evenly over the working range;
- calculate mean values for each concentration;
- carry out a linear regression analysis with the mean values and test the linearity of the calibration function (see also ISO 8466-1).

The function shall be linear. Otherwise, the working range shall be restricted to the linear range.

This calibration should be carried out for initial validation purposes or after major changes of the equipment.

### 10.2.5 Control measurements

Control measurements should be carried out using control mixture (8.11) or using pure chemicals (e.g. 8.5, 8.6, 8.10). Analysis of one concentration from the middle of the respective working range, possibly repeated two or three times, is sufficient.

Blank values shall be taken into account if necessary.

If the required recoveries are not achieved, the following measures can be helpful.

For TOC analysis:

- checking the homogeneity of the control mixture;
- increase the oxygen content in the reaction chamber, so as to work in excess of oxygen;
- clean the instrument by cleaning the oxidation tube: removal of ashes from the oxidation tube;
- checking the calibration;
- increasing the combustion temperature;

- reducing the flow of the carrier gas;
- encouraging a turbulent flow in the combustion tube;
- using modifiers;
- using post-oxidation of the combustion gases by catalysts.

### 10.3 Method B – determination TC and TIC - indirect method

#### 10.3.1 Determination of the TC

Burn the sample in the carrier gas containing oxygen (8.15).

The combustion temperature shall be high enough to convert the organic and inorganic carbon completely to carbon dioxide. The use of catalysts e.g. copper may increase the recovery.

The temperature range of commercially available instruments is between 900 °C and 1 500 °C.

During the combustion of reactive samples explosion or fuming may be prevented by covering the sample with inert material e.g. silica sand, aluminium oxide or glass wool plug.

The total carbon dioxide released during the combustion is measured using one of the detection methods infrared spectrometry, thermal conductivity detection, or other suitable techniques, and is expressed as carbon.

#### 10.3.2 Calibration TC

If a relative method is used for detection, e.g. infrared detection, calibration is necessary. The calibration for TC shall be done in accordance with the calibration for determination of TOC (10.2.4). The same calibration substances can be used.

#### 10.3.3 Determination of the TIC

The system is closed gas-tight and flushed with carrier gas until no more carbon dioxide from ambient air is present. Then acid (8.13) is added and the carbon dioxide is stripped by purging or stirring and/or heating. The released carbon dioxide is transferred to the detector by the carrier gas.

NOTE 5 The addition of wetting agents, e.g. water or surfactants, can improve wetting of the surface of the sample.

NOTE 6 The addition of anti-foaming agents, e.g. silicone oil, can be helpful in the case of strongly foaming samples.

The amount of carbon dioxide released during the gas evolution is measured e.g. by infrared spectrometry, thermal conductivity detection, or other suitable techniques and is expressed as total inorganic carbon (TIC).

#### 10.3.4 Calibration TIC

If a relative method is used for detection, e.g. infrared detection, calibration is necessary.

Calibration is to be performed according to the manufacturer's instruction.

Examples of calibration substances suitable for TIC are calcium carbonate (8.9) or sodium carbonate (8.10).

If calcium carbonate (8.10) is used as control substance, only calcium carbonate (8.10) from different producer or from different partition may be used for calibration.

Other calibration substances may be used provided their suitability is checked.

The following procedure should be applied for calibration:

- establish the preliminary working range;
- measure a minimum of five standard samples. The concentration of these standard samples shall be distributed evenly over the working range;
- carry out a linear regression analysis with the mean values and test the linearity of the calibration function (see also ISO 8466-1).

## **11 Calculation and expression of results**

### **11.1 Method A calculation**

The TOC mass contents of the samples prepared according to Clause 7 are calculated from:

- calibration function and sample mass if relative detection methods are used;
- specific constants and sample mass if absolute detection methods are used.

The TOC is calculated on dry matter basis by Formula (2). For this purpose the water content determined separately and, if necessary, the dilution factor resulting from sample preparation is used (see Formula (1)).

In case of mixing the sample with aluminium oxide (see 10.2.1) a dilution factor following Formula (1) shall be used:

$$f = (m_s + m_a) / m_s \quad (1)$$

where

$m_s$  is the mass of the sample, in g;

$m_a$  is the mass of aluminium oxide, in g.

$$m_{\text{TOC,dm}} = \frac{f \times m_{\text{TOC}}}{100 - w} \times 100 \quad (2)$$

where

- $m_{\text{TOC,dm}}$  is the TOC content as carbon, calculated on dry matter basis, in %;
- $m_{\text{TOC}}$  is the TOC content as carbon in the sample as received for analysis, in %;
- $w$  is the water content of the sample as mass fraction in %, according to CEN/TS 17773;
- $f$  is the dilution factor resulting from the sample preparation of the sample according to 10.2.1 (see Formula (1)).

The TOC content is reported as carbon on a dry matter basis. According to Formula (2) results are obtained in percent (%), but other units may be used.

### 11.2 Method B calculation

$$m_{\text{TOC}} = m_{\text{TC}} - m_{\text{TIC}}$$

where

- $m_{\text{TOC}}$  is the TOC content in the sample as received for analysis, in %;
- $m_{\text{TC}}$  total carbon in the sample as received for analysis, in %
- $m_{\text{TIC}}$  **total inorganic carbon** in the sample as received for analysis, in %

In the presence of urea or urea condensates [crotonyliden diurea (CDU) and isobutyliden diurea (IBDU)], the TOC content shall be corrected by subtracting the carbon ( $m_{\text{C}}$ ) coming from urea, IBDU or CDU from  $m_{\text{TOC}}$ , according to Formula (3):

$$m_{\text{TOCbiological}} = m_{\text{TOC}} - m_{\text{c(urea,CDU,IBDU)}} \quad (3)$$

where

- $m_{\text{C(urea)}} = 0,4287 \times N_{\text{ureic}}$ ;
- $m_{\text{C(CDU)}} = 1,28625 \times N_{\text{CDU}}$ ;
- $m_{\text{C(IBDU)}} = 1,28625 \times N_{\text{IBDU}}$ ;
- $N_{\text{ureic}}$  is the nitrogen content in the fertilizer formed from urea, according to CEN/TS 17771;
- $N_{\text{CDU}}$  is the nitrogen content in the fertilizer formed from CDU, according to EN 15705;
- $N_{\text{IBDU}}$  is the nitrogen content in the fertilizer formed from IBDU, according to EN 15705;
- NOTE 7 EN 15705 is applicable only for inorganic fertilizers.
- 0,4287 is the conversion factor for the content of nitrogen from urea in the fertilizer into the carbon content;
- 1,286 is the conversion factor for the content of nitrogen from CDU or IBDU in the fertilizer into the carbon content.

## **12 Test report**

The test report shall contain at least the following information:

- a) all information necessary for the complete identification of the sample;
- b) test method used with reference to this document (CEN/TS 17776:2022);
- c) information on applied pre-treatment procedure;
- d) test results obtained expressed as percent (%) of TOC in the fertilizer;
- e) information of determined and subtracted amount of carbon from urea and urea-condensates carbides, if relevant;
- f) date of sampling and sampling procedure (if known);
- g) date when the analysis was finished;
- h) whether the requirement of the repeatability limit has been fulfilled;
- i) all operating details not specified in this document, or regarded as optional, together with details of any incidents occurred when performing the method, which might have influenced the test result(s).

## Annex A (informative)

### Example of operational information

Table A.1 — Table of examples<sup>2</sup>

Parameters	Laboratory 1	Laboratory 2	Laboratory 3
Sample preparation: grinding modality	Retsch® SM 300 Cutting Mill and Retsch® ZM 200 Ultra Centrifugal Mill	RETSCH® GM 200 Knife Mill	Retsch® MM400 Mixer Mill
Sample preparation: type and size of the sieve	Sieved at 0,5 mm	Giuliani® sieve, UNI 2331-2 with 0,5 mm sieve	Sieved at 0,5 mm
Sample mass weighed for analysis	<p><u>TOC VARIO SELECT®</u> (macro)</p> <p>TOC 1 % to 5 %; mass 50 mg to 10 mg;</p> <p>TOC 5 % to 10 %; mass 35 mg to 10 mg;</p> <p>TOC 10 % to 20 %; mass 15 mg to 5 mg;</p> <p>TOC 20 % to 40 %; mass 7 mg to 2,5 mg.</p> <p><u>CHNS-O, Carlo Erba®</u> (micro)</p> <p>TOC 1 % to 5 %; mass 50 mg to 10 mg.</p> <p>TOC 5 % to 10 %; mass 20 mg to 3,5 mg</p> <p>TOC 10 % to 20 %; mass 10 mg to 2 mg;</p> <p>TOC 20 % to 40 %; mass 10 mg to 1 mg.</p>	<p>TOC 1 % to 10 %; mass 200 mg to 150 mg;</p> <p>TOC 10 % to 30 %; mass 100 mg to 110 mg;</p> <p>TOC 30 % to 50 %; mass 60 mg to 80 mg;</p> <p>TOC &gt; 50 %; mass 30 mg to 40 mg.</p>	<p>TOC 1 % to 5 %; mass 10 mg to 5 mg;</p> <p>TOC 5 % to 10 %; mass 5 mg to 2 mg;</p> <p>TOC 10 % to 20 %; mass 3 mg to 1 mg;</p> <p>TOC 20 % to 40 %; mass 1 mg to 0,5 mg.</p>
Size of the crucible used	40 mm × 40 mm  The sample is closed in a silver sheet.	35 mm × 35 mm  The sample is closed in tin sheet.	5 mm × 9 mm tin crucible  Silver crucible, in case of acid attack.

Parameters	Laboratory 1	Laboratory 2	Laboratory 3
Tool used for analysis	TOC VARIO SELECT® Elementar (macro) CHNS-O, Carlo Erba® (micro)	CNS, ELEMENTAR, VARIO MACRO® model	Thermo Scientific™ Flash 2000 CHNS-O
Temperature of combustion	Combustion temperature 950 °C	— Combustion temperature: 1 050 °C; — Post-combustion temperature: 800 °C; — Reduction temperature: 850 °C.	— Combustion in excess of oxygen; — Combustion temperature: 1 000 °C.
Catalyst	Combustion pipe packed with copper oxide and quartz flakes.	— Combustion catalyst: tungsten oxide; — 5 % CuO + Pt post-combustion catalyst; — Reduction catalyst: copper.	— Combustion pipe packed with chromium oxide and silver-plated cobalt oxide; — Reduction tube at 650 °C packed with reduced copper wires.
Gas carrier	Oxygen	Helium	Helium
Detector	IR (Infrared) detector	TCD (Thermal Conductivity Detector)	TCD (Thermal Conductivity Detector)



## Bibliography

- [1] *Regulation (EU) 1009/2019 of the European Parliament and of the Council of 5 June 2019 laying down rules on the making available on the market of EU fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 and repealing Regulation (EC) No 2003/2003. Official Journal of the EU, L 170*
- [2] *EN 15936, Sludge, treated biowaste, soil and waste — Determination of total organic carbon (TOC) by dry combustion*
- [3] *ISO 8466-1, Water quality — Calibration and evaluation of analytical methods — Part 1: Linear calibration function*